RAFFLES INSTITUTION RAFFLES PROGRAMME - YEAR FOUR CHEMISTRY

PERIODIC TABLE

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Periodic Table: An arrangement of the elements in order of increasing proton/atomic number.
The position of any element is related to its **proton number** and **electronic structure**.

Groups: Vertical columns in the Periodic Table.
Elements in the same group have the **same number of valence electrons** and hence tend to form **ions of similar charge** as they lose/gain the same number of valence electrons to achieve **noble gas configuration**.
Elements in the same group also tend to have **similar chemical properties** (acting as a metal/non-metal) as a result.
However, they tend to have **different physical properties** - increasing/decreasing trend along the group.

For instance, elements in Groups I to III (metals) normally have 1 to 3 valence electrons. Hence, they tend to lose valence electrons to achieve noble gas configuration, forming cations in the process.
Elements in Groups VI to VII (non-metals) normally have 5 to 7 valence electrons. Hence, they tend to gain or share valence electrons to achieve noble gas configuration, forming anions in the process.
Elements in Group O (noble gases) have a full valence electron shell/noble gas configuration. Hence, they tend not to gain, lose or share electrons, causing them to be unreactive.

Periods: Horizontal rows in the Periodic Table.
Elements in the same period have the **same number of electron shells**.
Across the period (left to right), the **metallic nature of elements decreases**, the size of the atom/**atomic radius decreases**, and the **structure of the oxides formed** (ionic or molecular) changes. Metal oxides tend to be ionic while non-metal oxides tend to have molecular structure.

Trends in the Periodic Table

Nuclear Charge: Amount of positive charge in the nucleus. Equivalent to Atomic/Proton Number.
Across the period and down the group, nuclear charge increases.

Shielding Electrons: All inner-shell electrons/electrons not in the valence shell. They shield the valence electrons from the electrostatic forces of attraction from the positively-charged nucleus/nuclear charge. Across the period, number of shielding electrons remains constant. Down the group, number of shielding electrons increases as the number of electron shells increases.

Atomic Radii: Distance between valence electron shell and nucleus of atom. Affected by **BOTH** nuclear charge and shielding electrons.
Decreases across the period: Nuclear charge increases while number of shielding electrons remains constant. Hence, valence electrons are increasingly attracted to the nucleus across the period.
Increases down the group: Nuclear charge and shielding electrons both increase. However, between the two, the shielding effect has a greater effect on the atomic radius as not only do the number of shielding electrons increase, the valence electrons are also increasingly further from the nucleus because of the added electron shell. Hence, valence electrons are decreasingly attracted to the nucleus down the group.

Ionic Radii:
Metals have cations with **smaller ionic radius**. When the metal atom loses electrons, the **electron-electron repulsion force** between remaining electrons decreases. Also, there are now **more protons than electrons** so the protons are better able to pull the remaining electrons towards the nucleus.
Non-Metals have anions with **larger ionic radius**. When the non-metal atom gains electrons, the **electron-electron repulsion force** between electrons increases. Also, there are now **less protons than electrons** so the protons are cannot pull the electrons as tightly towards the nucleus.

Trends within groups in the Periodic Table

Metals	- Usually solids at rtp (except Mercury Hg) - High melting and boiling points except Group 1 Metals - Good thermal and electrical conductivity - Often shiny, ductile and malleable - Always form cations by losing electrons
Alkali Metals Group I	- Relatively soft, low density metals (lower density than water and floats) - Low melting and boiling points - Form alkaline solutions (respective metal oxide/hydroxide) with water - Reactivity and Density increase down group - Melting point decreases down group
Non-Metals	- Often gases at rtp (except Carbon C, Phosphorus P, Sulfur S, and Silicon Si) - Low melting and boiling points (except Carbon C and Silicon Si) - Poor thermal and electrical conductivity (except graphite that conducts electricity) - Normally dull and soft - Usually form anions by gaining electrons
Halogens Group VII	- Reactive non-metals that typically exist as diatomic molecules - Melting point increases down group; At rtp, fluorine and chlorine are gases, bromine is liquid, and iodine is solid. - Colour intensity increases down group; Fluorine is pale yellow, Chlorine is yellow-green, Bromine is reddish brown and Iodine (solid) is black. - Reactivity decreases down group. A more reactive halogen can displace a less reactive halogen from its salt solution (Displacement reaction)
Noble Gases Group O	- Unreactive/Inert non-metals that typically exist as monatomic gases - Hence used to provide an inert atmosphere (eg. Argon and Neon in lightbulbs, Helium in balloons, Argon in steel manufacturing) - Density increases down group
Transition Metals Central Block	- Metals that show variable oxidation states in their compounds - Hence, used as catalysts as they remain chemically unchanged at the end of reactions. (eg. Iron is a catalyst in the Haber process – See “EQUILIBRIA”) - High melting and boiling points - High density - Form coloured compounds

Types of Oxides (BAM NAN) [From “ACIDS AND BASES”]

BAM - Metal oxides are either Basic or Amphoteric.

Basic Oxides react with acids.	(Sodium Na_2O, Calcium CaO, Copper(II) CuO)
Amphoteric Oxides react with both acids and bases.	(ZAP - Zinc ZnO, Aluminum Al_2O_3, Lead(II) PbO, Gallium Ga_2O_3 not in)

NAN - Non-metal oxides are either Acidic or Neutral.

Acidic Oxides react with bases.	(Carbon Dioxide CO_2, Sulfur Dioxide SO_2, Nitrogen Dioxide NO_2)
Neutral Oxides do not react with acids and bases.	(Carbon Monoxide CO, Nitric Oxide NO, Water H_2O)

[To remember, acidic oxides have higher oxidation states while neutral oxides have lower oxidation states.]

Generally, basic, amphoteric and neutral oxides are insoluble while acidic oxides are soluble in water.